

The first two sections, both of them on Ancient Bristol, are by Mr. J. Taylor, of the Bristol Library. Section 3, on Modern Bristol, is by Mr. J. F. Nicholls, of the City Library. The fourth section, on Local Government and Taxation, is by Mr. H. Naish: and then follows a section on Educational Organisations, to which there are several contributors. Mr. D. Davies, the medical officer of health, has supplied the section on Sanitary Condition and Arrangements, after which comes Section 7, on Physical Geography and Geology. This occupies sixty-four pages, and would perhaps have been of more practical use if printed as a separate pamphlet that could be conveniently carried in the pocket. Mr. Tawney has written the Introduction; the Silurian, the Carboniferous, and Millstone Grit is by Mr. Stoddart; the part on the Coal Measures and "New Red Period" is written by Mr. Tawney; that on the Rhaetic and Liassic by Mr. Ralph Tate, and the concluding part on the Inferior Oolite is again by Mr. Tawney.

Bristol is better off for geological maps than any other part of the country, for not only are there the sheets of the Geological Survey, but there is Mr. Sanders' splendid map of six inches to the mile, which includes the whole of the Bristol coal-field.

It is a pity there was not a sketch map introduced in the guide, with just the names given of the places referred to and an indication of the spots where the sections are taken from. As it is, strangers to the district will experience some difficulty in following the text, as many of the names are not on the published maps. With regard to the sections, too, there is no indication of the direction in which they are taken, nor of the scale to which they are drawn. One of the most useful features of the geological portion is that which gives the localities where the sections of the strata can be seen; and, as the district within a short distance contains from the Silurian up to the Oolites, omitting the Permian, is of interest. There are many references to the more important papers that have been printed, and in cases of difference of opinion the writer has added his own views. The much vexed question of the age of the "dolomitic," "triassic," "magnesian," or "reptilian" conglomerate, is duly referred to.

The notes on anthropology have reference to the tumuli and chambered barrows, and to the present condition of Bristolians. "A certain amount of physical degeneration has taken place among the native Bristolians, as among the natives of other British cities; 300 of them yielded to me an average stature and weight of 5 feet 5'8 inches and 132½ lbs., after deductions made for shoes and clothing. The average height of men in the surrounding counties may fairly be put at half an inch more."

The book has one serious defect, for which the compiler and not the authors are responsible; there is no index.

#### LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.]

#### "Climate and Time"

THE review of "Climate and Time" in NATURE, vol. xii. p. 121, contains some remarks in reference to my tables of the eccentricity of the earth's orbit, to which, in justice to myself, I must refer, the more so as they relate to points which comparatively few of your readers have it within their power to determine whether or not the reviewer was justified in making the remarks in question.

"We have repeated," says the reviewer, "the calculations for two of the most remarkable dates, viz., 850,000 and 900,000 years ago respectively, and find that at the former date the eccentricity was '0697 instead of '0747, and at the latter date was '0278 instead of '0102 as expressed in the table."

What proof does the reviewer give that his results are correct and mine incorrect? The following is the reason he assigns:—"To satisfy ourselves," he says, "that the mistakes are Mr. Croll's and not ours, we have recalculated also one of Mr. Stone's and one of M. Leverrier's, and in both instances have exactly verified them." This can hardly be accepted as sufficient evidence, for I had myself recalculated one of Mr. Stone's and no fewer than five of M. Leverrier's, "and exactly verified them."

I suspect that the reviewer has made his calculations somewhat too hastily; for if he will go over them a little more carefully, he will, I have no doubt, find that after all my results are perfectly correct, excepting only a trifling typographical error, to which I shall presently refer.

The value for 900,000 years ago ought to be '0109 instead of '0102, as stated in the table. This mistake arose out of the curious circumstance of a small speck of ink having been dropped on the tail of the 9, which led to its having been substituted for a 2, ten years ago when the tables were first published—a fact of which I was not aware till a week or two ago, when looking over the manuscripts of my original calculations, all of which I have preserved. Since my calculations were called in question by your reviewer, I have had them examined by three experienced mathematicians, and the conclusion at which each of them has arrived is that they are perfectly correct.

The reviewer continues:—"The fact that the eccentricity was large when he represents it so, and small when he makes it small, seems to indicate that some approximating progress [process?] has been followed, and that possibly his diagram may give a rough idea of the changes of eccentricity for past time."

I can assure the reviewer that nothing could be further from the truth than this assumption. I have computed the eccentricity and longitude of the perihelion for no fewer than 129 separate periods, and in every case Leverrier's formulæ have been rigidly followed, and I have every reason to believe that the diagram gives not a rough but an accurate idea of the changes of eccentricity. The values given in the tables will, I trust, be found to be perfectly accurate up to at least the fourth place of decimals, which is as far as these formulæ can be relied upon to yield correct results.

The following are the results which, considering the trouble that has been given to their verification, I think will stand the most severe scrutiny:—

Period 850,000 years ago.	Period 900,000 years ago.
$h^2 = '00413927$	$h^2 = '000059858$
$l^2 = '00144124$	$l^2 = '000059812$
$h^2 + l^2 = '00558051$	$h^2 + l^2 = '000119670$
$\sqrt{h^2 + l^2} = '0747 = \text{Eccentricity}$	$\sqrt{h^2 + l^2} = '010939 = \text{Eccentricity}$

Edinburgh, August 10

JAMES CROLL.

#### A Lunar Rainbow, or an Intra-lunar convergence of Streams of slightly illuminated Cosmic Dust?

ABOUT 8.30 P.M. yesterday a large zone of the sky, from the horizon at W.N.W. to the horizon at E. by S., was illuminated in a very remarkable manner, and this illumination lasted about three-quarters of an hour, when it gradually died out.

During all this time the sky was very clear and cloudless, thereby forming a dark back-ground, on which the phenomenon, whether lunar rainbow, or many rainbows, or intra-lunar converging streams of cosmic matter, was splendidly projected.

This exhibition consisted of one grand central feather springing out of the horizon at W.N.W. and crossing this meridian at about 20° north of the zenith. The width of this stream, with little variation throughout its length, was 7° or 8°. Its light was that of a very bright white cloud, its edges most beautifully defined; its form that of a very elongated feather, but without any shaft. On either side of this main feather was a system of seven or eight minor and fainter streams, threads, or beams of light, all more or less extending from the western to the eastern horizon, subtending a chord common to themselves and to the main stream of light, and converging towards the axis of the central stream so as apparently to intersect it at a point about 30° or 40° below the western horizon, at which the whole system subtended an azimuth of about 20°; and near the zenith, where its transverse section was a maximum, that section subtended an angle of about 40°. At this time the moon was about 15° east of the meridian, and her declination about 9° S. Both systems of the minor streams of light on the sides of the main stream appeared to have a slight

libratory motion, or to slew upwards towards the main stream, and therefore perpendicularly to their length.

Nothing could suggest to the mind more strongly the idea of converging streams of infinitely minute particles of matter passing through space at a distance from the earth less than that of the moon, and at which the earth's aërial envelope may still have a density sufficient, by its resistance, to give to cosmic dust passing through it with planetary velocity that slight illumination which it possessed.

The rapid development of the luminosity of these streams on this occasion is evidenced by the fact that they were observed at the time of leaving church, namely, 8 P.M. to 8.20 P.M., by none of the several congregations of this town and Perth, but were observed by many persons from a quarter to half an hour after that time, so far as I have yet been able to ascertain by a rather extensive inquiry. On coming out of church I myself certainly looked round the whole visible horizon and the higher portion of the heavens, and I made to a companion some observations on the clearness of the stars and dark blue colour of the sky; but about twenty minutes after my exit from church these streams of light had attained their maximum of illumination.

Their apparent figure was that of a nearly circular (slightly flattened) arc of an amplitude of 15° or 20°, as viewed from the middle point of its chord. Both the brightness and the convergence of the streams towards the western horizon were more marked than those towards the eastern horizon.

Fremantle, West Australia, May 17 J. W. N. LEFROY

PS.—Since writing the above, in the Supplement of the *South Australian Register* of Thursday, May 20, I have found the following paragraph:—

"A beautiful lunar rainbow was visible in the western heavens on the evening of Sunday, the 16th inst., a few minutes after 8 o'clock. For a short time the arch was nearly perfect, but for upwards of fifteen minutes the limbs were very bright. The southern limb also appeared visible for some time after the upper portion of the arch had faded away."

Now, allowing for the difference of local time between Fremantle and Adelaide, I think it fairly assumable that this paragraph must refer to the same phenomenon which I have attempted to describe as above; and, if so, it clearly shows that it was *not* a lunar rainbow. I can find no allusion to it in any Melbourne paper yet received here, and which reach to the 19th inst. There the sky may that evening have been cloudy, and thus have rendered it invisible. All intelligent persons here who observed it, and with whom I have had opportunity of conversing since the 16th inst. to this day, concur in my impression that minor lateral streams or feathers of light on the north side of the main stream intervened between the earth and the moon, and one or more of them in its slow librations swept the surface of the moon and sensibly obscured its light.—J. W. N. L.

May 31

#### "Instinct" and "Reason"

A FEW facts came under my observation during the spring of this year that strikingly illustrate this subject. A pair of black-birds built a nest on the top of my garden wall, which is thickly covered with ivy and within three yards of the drawing-room window. When the young birds were about three parts fledged one of them by some mishap left the nest and fell into the flower garden. My cat (seven years old, and which has killed scores of small birds) immediately found it, and at the same time a kitten (about three months old, but not belonging to the cat) began to pay rather rude attentions to the young blackbird, and would have used it as kittens are wont, but the old cat would not suffer her to touch it. The cause of this was the old cock blackbird, being aware of the peril of its young, made a great noise and kept flying here and there around the scene of action, crying and scolding with might and main. It then became evident to me that the cat had two or three objects in view, and a purpose to gain. Firstly, not to allow the kitten to touch, or kill, or make off with the young bird. Secondly, to use the young bird as a decoy to entrap the old one. Thirdly, to make the young bird cry sufficiently from fear or pain to induce the parent's affection to overcome its discretion.

During the manoeuvres old Tom repeatedly made unsuccessful springs to catch the cock-bird, alternately running to give the kitten a lesson of patience, or self-denial, or impose a fear of punishment. The young bird repeatedly hopped out of sight amongst the flowers and stinted its cries; then anon the

cat touched it again and made it flutter about and cry again, which from time to time brought the old bird down with cries of terror, or wrath, or a blending of both emotions, and almost into the very mouth of the cat. Two or three times I thought old Tom was successful, but no, he missed his object most surprisingly. It became evident to me that the cat was using the young bird as a decoy to catch the old one. After I had watched some ten or fifteen minutes, it became too painful for me to witness, so I caught the young bird and put it again into its nest, which was about ten feet from the ground.

In less than an hour the young bird was again on the ground, the cat, kitten, and parent bird performing the same drama, with this difference in the acting: the cat lay down, rolled about, or sat at a convenient distance from the young bird, yet with eyes alert, though half shut, and otherwise giving an assurance that he did not intend to make another bound without succeeding to catch his prey. He was, however, disappointed, and made four without achieving his purpose. At this juncture the mother-bird came on the stage with cries of distress, but kept aloof on the branches of a tall cherry-tree that rises above the wall; and if her boldness were less than the cock-bird's, her discretion was greater, for she kept far aloft. Once it seemed to me that the cock-bird actually struck the back or head of the cat with his wing and mandible. This scene continued about seven or ten minutes, when I again caught the young bird and threw it over the wall, and the exhibition of animal thought, emotion, and passion ceased.

Here were manifested phenomena of a more remarkable kind than those seen in the cases cited by the Duke of Argyll in the *Contemporary Review* for July, in an article to illustrate "Animal Instinct in relation to the Mind of Man," for the cat showed an amount of reasoning which he probably never before exercised, because never before placed in the same circumstances. That he had used young sparrows, of which he must have caught scores, as decoys to catch the old ones is possible, but I am perfectly sure that no kitten ever was in the garden during his reign as "monarch of all he surveyed" in the shape of birds. Hence his authority over the kitten, which was full of life and eagerness to appropriate the young bird, the killing of which would have defeated the purpose of the cat in using the young bird as a decoy to catch the old one, was indeed remarkable, and disclosed a combination of mental forces of self-conscious reason of no trifling order, and, as it appears to me, conclusive that the difference—and only difference—between instinct and reason is one of degree.

JAMES HUTCHINGS

Banbury, Aug. 16

#### OUR ASTRONOMICAL COLUMN

DOUBLE STARS.—Dr. Doberck, of Markree Observatory, has published a first approximation to the elements of  $\zeta$  Aquarii, on measures between 1781 and 1870, in which long interval, however, the angle of position has only changed 45°—a case where very great latitude must be allowed to any orbit that may be deduced. Dr. Doberck fixes the peri-astron passage to 1924'15, and assigns a period of revolution of upwards of 1,500 years. The latest measures we have met with are those of Nobile, taken at the Observatory of Naples in November 1873, giving the angle 335°5, or 3°4 greater than that calculated.—There appears now a probability that the smaller component of 44 Bootis has passed its greatest apparent distance from the primary several years since: if good measures of distance have been made this year, they ought to be sufficient to enable us to pronounce definitely upon this point. That this star forms a true binary there can be no doubt, though it is Sir W. Herschel's measures in 1781 and 1802 alone, that afford conclusive evidence of the physical connection of the components. Thus we might represent the measures between Struve's earliest in 1819 and the present time by the formulae

$$\Delta a = -3''\cdot4233 - [8\cdot8968] (t - 1830\cdot88)$$

$$\Delta \delta = -1\cdot6979 - [8\cdot3115] (t - 1830\cdot88)$$

But if we calculate from the same formulae for Sir W. Herschel's epochs we find,

$$1781\cdot62 \quad \text{Position } 156^\circ\cdot1 \quad \text{Distance } 0''\cdot75$$

$$1802\cdot25 \quad , \quad 214\cdot8 \quad b, \quad 1\cdot35$$